

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) An antenna apparatus comprising:
a plurality of antenna units for respectively transmitting and receiving a radio signal using a main beam of a sector pattern thereof;
at least one load impedance element; and

~~control means~~ a controller for controlling the antenna apparatus so that the antenna unit that transmits and receives the radio signal of the plurality of antenna units is connected to a radio communication apparatus circuit and the other antenna units are connected to the load impedance element.

2. (Original) The antenna apparatus as claimed in Claim 1,
wherein the plurality of antenna units is arranged so that directions of the main beams of the respective antenna units are different to each other.

3. (Original) The antenna apparatus as claimed in Claim 1,
wherein the plurality of antenna units is arranged so that directions of the main beams of the respective antenna units are orthogonal to each other.

4. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims~~
Claim 1 to 3,

wherein the ~~control means~~ controller controls the antenna apparatus so that the antenna unit that receives the radio signal having the maximum signal level among the radio signals received by the respective antenna units is connected to the radio communication apparatus circuit.

5. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims~~
Claim 1 to 4,

wherein the plurality of antenna units is respectively formed by waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a

ground conductor, each of waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two side conductors that connect the ground conductor with the ceiling conductor and face each other, and has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

6. (Original) The antenna apparatus as claimed in Claim 5,

wherein the plurality of waveguide antenna units has substantially the same structure as each other, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

7. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims~~ Claim 1 to 4,

wherein the plurality of antenna units is respectively formed by a waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a

ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two side conductors that connect the ground conductor with the ceiling conductor and face each other, and has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor, and at least one of the rectangular waveguides comprises at least one slot formed in the ceiling conductor in a width direction of the rectangular waveguide,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

8. (Original) The antenna apparatus as claimed in Claim 7,

wherein the waveguide array antenna apparatus comprises slots of the same number as an integral multiple of number of the feeding points, the slots are provided in each of the ceiling conductors constituting the waveguide antenna units of the same number as that of the feeding points, the numbers of the slots provided on the respective ceiling conductors are equal to each other, the plurality of the waveguide antenna units has the same structure as each other, the open ends of the rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

9. (Currently Amended) The antenna apparatus as claimed in Claim 7-~~or 8~~, wherein the slots are respectively formed at positions between connecting points with the antenna elements of the ceiling conductors, and the terminating conductors.

10. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims Claim 5 to 9~~,
Claim 5 to 9,

wherein at least one part of an internal space in each of the rectangular waveguides is filled with a dielectric material.

11. (Original) The antenna apparatus as claimed in Claim 10, wherein the ground conductor is made of an electrical conductor pattern formed on a first surface of a dielectric substrate having first and second surfaces opposing to each other,

wherein the respective ceiling conductors are made of an electrical conductor pattern formed on the second surface of the dielectric substrate, and

wherein the side conductors and the terminating conductors are respectively formed by a plurality of through-hole conductors formed by filling through holes formed in the dielectric substrate in a thickness direction thereof with conductors.

12. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims Claim 1 to 4~~,
Claim 1 to 4,

wherein the plurality of antenna units is respectively formed by a waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two partitioning-wall conductors that connect the ground conductor with the ceiling conductor and face each other, the rectangular waveguides are arranged in such manner that the partitioning-wall conductors are respectively shared between the two rectangular waveguides adjacent to each other,

each of the rectangular waveguides comprises one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

13. (Original) The antenna apparatus as claimed in Claim 12,

wherein the plurality of waveguide antenna units has the same structure as each other, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

14. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims~~ Claim 1 to 4,

wherein the plurality of antenna units is respectively formed by a waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two partitioning-wall conductors that connect the ground conductor with the ceiling conductor and face each other, the rectangular waveguides are arranged in such manner that the partitioning-wall conductors

are respectively shared between the two rectangular waveguides adjacent to each other, each of the rectangular waveguides has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor, and at least one of the rectangular waveguides comprises at least one slot formed in the ceiling conductor in a width direction of the rectangular waveguide,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

15. (Original) The antenna apparatus as claimed in Claim 14,

wherein the waveguide array antenna apparatus comprises slots of the same number as an integral multiple of number of the feeding points, slots are provided in the ceiling conductors constituting the waveguide antenna units of the same number as that of the feeding points, the numbers of the slots provided in respective ceiling conductors are equal to each other, the plurality of the waveguide antenna units has the same structure as each other, the open ends of the rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

16. (Currently Amended) The antenna apparatus as claimed in Claim 14 ~~or 15~~,

wherein the slots are respectively formed at positions between connecting points with the antenna elements of the ceiling conductors, and the terminating conductors.

17. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims~~
Claim 12 to 16,

wherein at least one part of an internal space in each of the rectangular waveguides is filled with a dielectric material.

18. (Original) The antenna apparatus as claimed in Claim 17,
wherein the ground conductor is made of an electrical conductor pattern formed on a first surface of a dielectric substrate having first and second surfaces opposing to each other,

wherein the ceiling conductors are each made of an electrical conductor pattern formed on the second surface of the dielectric substrate, and

wherein the partitioning-wall conductors and the terminating conductors are respectively formed by a plurality of through-hole conductors formed by filling through holes formed in the dielectric substrate in a thickness direction thereof with conductors.

19. (Canceled)

20. (Canceled)

21. (Canceled)

22. (Canceled)

23. (Canceled)

24. (Canceled)

25. (Canceled)

26. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims Claim 1 to 25~~,

wherein the ~~control means~~ controller comprises:

a plurality of first switch ~~means~~ provided to respectively correspond to the respective antenna units; and

a second switch means connected to the first switch ~~means~~, and

wherein each of the first switch ~~means~~ selectively connects the respective antenna units to one of the second switch ~~means~~ and the load impedance element,

wherein the second switch ~~means~~ selectively connects one of the plurality of first switch ~~means~~ to the radio communication apparatus circuit, and

wherein the ~~control means~~ controller controls the plurality of first switch ~~means~~ and the second switch ~~means~~, so that, among the plurality of antenna units, the antenna unit that transmits and receives the radio signal is connected to the radio communication apparatus circuit, and the other antenna units are connected to the load impedance element.

27. (Currently Amended) The antenna apparatus as claimed in ~~any one of Claims Claim 1 to 25~~,

wherein the ~~control means~~ controller comprises:

a plurality of first switch ~~means~~ provided to respectively correspond to the respective antenna units; and

a signal combiner and distributor means connected to the first switch ~~means~~, and

wherein each of the first switch ~~means~~ selectively connects the antenna units to one of the signal combiner and distributor means and the load impedance element,

wherein the signal combiner and distributor means combine the respective radio signals outputted from the plurality of first switch ~~means~~, and outputs a combined signal to the radio communication apparatus circuit, and

wherein the ~~control means~~ controller controls the plurality of first switch ~~means~~, so that, among the plurality of antenna units, the antenna unit that transmits and receives the radio signal is connected to the radio communication apparatus circuit, and the other antenna units are connected to the load impedance element.

28. (Canceled)

29. (Canceled)

30. (Canceled)

31. (Canceled)

32. (Original) A waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two side conductors that connect the ground conductor with the ceiling conductor and face each other, and has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

33. (Original) The waveguide array antenna apparatus as claimed in Claim 32,

wherein the plurality of waveguide antenna units has the same structure as each other, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the

same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

34. (Original) A waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two side conductors that connect the ground conductor with the ceiling conductor and face each other, and has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor, and at least one of the rectangular waveguides comprises at least one slot formed in the ceiling conductor in a width direction of the rectangular waveguide,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

35. (Original) The waveguide array antenna apparatus as claimed in Claim 34,

wherein the waveguide array antenna apparatus comprises slots of the same number as an integral multiple of number of the feeding points, slots are provided in the ceiling conductors constituting the waveguide antenna units of the same number as that of the feeding points, the numbers of the slots provided on the respective ceiling conductor are equal to each other, the plurality of the waveguide antenna units has the

same structure as each other, the open ends of the rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

36. (Currently Amended) The waveguide array antenna apparatus as claimed in Claim 34 ~~or 35~~,

wherein the slots are respectively formed at positions between connecting points with the antenna elements of the ceiling conductors, and the terminating conductors.

37. (Currently Amended) The waveguide array antenna apparatus as claimed in ~~any one of Claims 32 to 36~~, Claim 32 to 36,

wherein at least one part of an internal space in each of the rectangular waveguides is filled with a dielectric material.

38. (Original) The waveguide array antenna apparatus as claimed in Claim 37, wherein the ground conductor is made of an electrical conductor pattern formed on a first surface of a dielectric substrate having first and second surfaces opposing to each other,

wherein the ceiling conductors are each made of an electrical conductor pattern formed on the second surface of the dielectric substrate, and

wherein the side conductors and the terminating conductors are respectively formed by a plurality of through-hole conductors formed by filling through holes formed in the dielectric substrate in a thickness direction thereof with a conductor.

39. (Original) A waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein, each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two partitioning-wall conductors that

connect the ground conductor with the ceiling conductor and face each other, the rectangular waveguides are arranged in such manner that the partitioning-wall conductors are respectively shared between the two rectangular waveguides adjacent to each other, each of the rectangular waveguides has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

40. (Original) The waveguide array antenna apparatus as claimed in Claim 39,

wherein the plurality of waveguide antenna units has the same structure as each other, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

41. (Original) A waveguide array antenna apparatus comprising a plurality of waveguide antenna units provided on a ground conductor, each of the waveguide antenna units including a rectangular waveguide and an antenna element,

wherein each of the rectangular waveguides comprises the ground conductor, a ceiling conductor facing the ground conductor, and two partitioning-wall conductors that connect the ground conductor with the ceiling conductor and face each other, the rectangular waveguides are arranged in such manner that the partitioning-wall conductors

are respectively shared between the two rectangular waveguides adjacent to each other, each of the rectangular waveguides has one end short-circuited by a terminating conductor and an open end, the open ends of the respective rectangular waveguides are arranged on corresponding sides of a polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, the rectangular waveguides extend outward from the corresponding sides of the polygon on the ground conductor, and at least one of the rectangular waveguides comprises at least one slot formed in the ceiling conductor in a width direction of the rectangular waveguide,

wherein one ends of the respective antenna elements are electrically connected to the ceiling conductors in vicinity of the open ends of the respective rectangular waveguides, and another ends thereof are electrically connected to each of a plurality of feeding points arranged on the ground conductor, and

wherein the waveguide antenna units respectively transmit and receive the radio signal using a predetermined directivity characteristic at the open ends of the rectangular waveguides constituting the waveguide antenna units.

42. (Original) The waveguide array antenna apparatus as claimed in Claim 41,

wherein the waveguide array antenna apparatus comprises slots of the same number as an integral multiple of number of the feeding points, slots are provided in the ceiling conductors constituting the waveguide antenna units of the same number as that of the feeding points, the numbers of the slots provided on the respective ceiling conductors are equal to each other, the plurality of the waveguide antenna units has the same structure each other, the open ends of the rectangular waveguides are arranged on corresponding sides of a regular polygon on the ground conductor having sides of the same number as that of the rectangular waveguides, and the respective rectangular waveguides extend outward from the corresponding sides of the regular polygon on the ground conductor.

43. (Currently Amended) The waveguide array antenna apparatus as claimed in Claim 41 ~~or 42~~,

wherein the slots are respectively formed at positions between connecting points with the antenna elements of the ceiling conductors, and the terminating conductors.

44. (Currently Amended) The waveguide array antenna apparatus as claimed in ~~any one of Claims~~ Claim 39 to 43,

wherein at least one part of an internal space in each of the rectangular waveguides is filled with a dielectric material.

45. (Original) The waveguide array antenna apparatus as claimed in Claim 44,
wherein the ground conductor is made of an electrical conductor pattern formed on a first surface of a dielectric substrate having first and second surfaces opposing to each other,

wherein the respective ceiling conductors are made of an electrical conductor pattern formed on the second surface of the dielectric substrate, and

wherein the partitioning-wall conductors and the terminating conductors are respectively formed by a plurality of through-hole conductors formed by filling through holes formed in the dielectric substrate in a thickness direction thereof with a conductor.

46. (Canceled)

47. (Canceled)

48. (Canceled)

49. (Canceled)

50. (Canceled)

51. (Canceled)

52. (Canceled)

53. (Canceled)

54. (Canceled)